

Claims

1. A balun comprising:
 - a first conductor having a length of about one quarter wavelength of a selected
 - 5 center frequency, the first conductor having a first end connected to a first balanced power amplifier output port;
 - a second conductor having a length of about one quarter wavelength of the selected center frequency, the second conductor includes:
 - a first end connected to a second balanced power amplifier output port;
 - 10 a second end connected a second end of the first conductor; and
 - a third conductor having a length of about one quarter wavelength of the selected center frequency, the third conductor having a first end connected to an antenna port and a second end connected to a ground potential.
- 15 2. The balun of claim 1, further comprising a biasing network including:
 - a fourth conductor having a first end connected to the first balanced power amplifier output port and a second end connected to a bias supply.
3. The balun of claim 2, wherein the fourth conductor has a length of about one
- 20 quarter wavelength of the selected center frequency.
4. The balun of claim 3, wherein the fourth conductor has a length that has a reactance that offsets a parasitic capacitance of at least one of the first conductor, the

second conductor, the third conductor, the first balanced PA port and the second balance PA port.

5 5. The balun of claim 1, wherein the first conductor, the second conductor and the third conductor are formed in a multi-layer structure including a plurality of metal layers interleaved by a plurality of insulating via layers.

6. The balun of claim 5, wherein the first conductor is formed in a first metal layer, the second conductor is formed in a second metal layer and the third conductor is formed
10 in a third metal layer in the multi-layer structure.

7. The balun of claim 6, wherein the second end of the first conductor is connected to the second end of the second conductor by a via connection formed in a via layer.

15 8. The balun of claim 6, wherein the first conductor, the second conductor, and the third conductor are substantially vertically aligned.

9. The balun of claim 8, wherein the multi-layer structure is bounded by a first ground plane and a second ground plane.

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10. The balun of claim 9, wherein the first ground plane and the second ground plane are separated by a distance H and the first conductor, the second conductor, and the third conductor are vertically offset less than ten times the distance H.

11. The balun of claim 5, wherein the multi-layer structure is formed in a homogenous medium.
12. The balun of claim 5, wherein the multi-layer structure is formed in at least one of a group of mediums consisting of LTCC, BT resin, Silicon and FR4.
13. A transceiver front end circuit comprising:
a first three coupled line balun including:
a first conductor having a length of about one quarter wavelength of a selected center frequency, the first conductor having a first end connected to a first balanced PA output port;
a second conductor having a length of about one quarter wavelength of the selected center frequency, the second conductor includes:
a first end connected to a second balanced PA output port; and
a second end connected a second end of the first conductor; and
a third conductor having a length of about one quarter wavelength of the selected center frequency, the third conductor having a first end connected to an antenna port and a second end connected to a ground potential;
a second three coupled line balun including:
a fourth conductor having a length of about one quarter wavelength of the selected center frequency, the fourth conductor having a first end connected to a first balanced LNA input port;
a fifth conductor having a length of about one quarter wavelength of the selected center frequency, the fifth conductor includes:

a first end connected to a second balanced LNA input port; and
a second end connected a second end of the fourth conductor; and
a sixth conductor having a length of about one quarter wavelength of the
selected center frequency, the sixth conductor having a first end connected to the antenna
5 port and a second end connected to the ground potential.

14. The transceiver front-end circuit of claim 13, further comprising:
a first switch connected between the first balanced PA output port and the second
balanced PA output port; and
10 a second switch connected between the first balanced LNA input port and the
second balanced LNA input port.

15. The transceiver front-end circuit of claim 14, further comprising:
a PA connected to the first balanced PA output port and the second balanced PA
15 output port; and
a LNA connected to the first balanced LNA input port and the second balanced
LNA input port.

16. The transceiver front-end circuit of claim 15, wherein the first switch is included
20 in the PA and the second switch is included in the LNA.

17. The transceiver front-end circuit of claim 13, further comprising a bias network
connecting a bias source to the first balanced PA output port.

18. The transceiver front-end circuit of claim 17, wherein the bias network includes a seventh conductor having a length of about one quarter wavelength of the selected center frequency.

5 19. A balun including:

an operating frequency RF equivalent circuit comprising:

a first conductor having a length of about one half wavelength of a selected center frequency, the first conductor having a first end coupled to a first balanced PA output port and a second end coupled to a second balanced PA output port;

10 a second conductor having a length of about one quarter wavelength of the selected center frequency, second conductor having a first end coupled to the first balanced PA output port and a second end coupled to an antenna port; and

a physical structure comprising:

15 a third conductor having a length of about one quarter wavelength of a selected center frequency, the third conductor having a first end connected to the first balanced PA output port;

a fourth conductor having a length of about one quarter wavelength of the selected center frequency, the fourth conductor includes:

a first end connected to the second balanced PA output port; and

20 a second end connected a second end of the third conductor; and

a fifth conductor having a length of about one quarter wavelength of the selected center frequency, the fifth conductor having a first end connected to an antenna port and a second end connected to a ground potential.

20. The balun of claim 19, wherein the third conductor, the fourth conductor and the fifth conductor are formed in a multi-layer structure including a plurality of metal layers interleaved by a plurality of insulating via layers and the third conductor is formed in a first metal layer, the fourth conductor is formed in a second metal layer and the fifth conductor is formed in a third metal layer in the multi-layer structure.